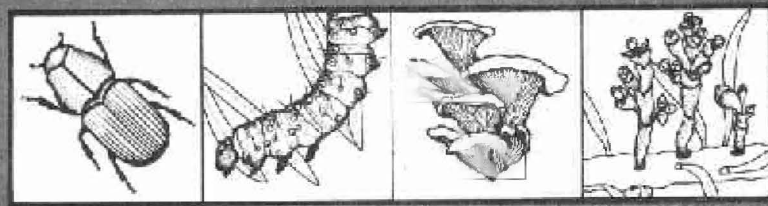
Forest Pest Management



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Report 85-7 March 1985

EVALUATION OF DOUGLAS-FIR MORTALITY FROM DOUGLAS-FIR BEETLE FROM 1982 THROUGH 1984 FOLLOWING MCH APPLICATION

by

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ABSTRACT

A granular controlled release formulation of 2 percent MCH was applied at 4.48 kg/ha to 76.9 ha of uninfested, windthrown Douglas-fir by helicopter with a modified aerial spreader of 1.12 m^3 capacity in May 1982. Douglas-fir beetle population reduction was 96.4 percent by late June. With one exception, treated plots had no successful attacks through 1984. Successfully attacked trees in stands surrounding treated plots declined sharply by the second season. This may indicate MCH dispersed beetles over a wide area preventing the development of many epicenters. Mortality remained high in check areas and surrounding stands. In all areas surrounding treated blocks and check areas, the number of pitchouts increased and average diameter of successfully attacked trees declined with successive years of infestation. This pattern is indicative to that experienced following a beetle population buildup in windthrow in other areas. We recommend MCH be registered at 2 percent controlled release formulation for application to inaccessible windthrown trees, and to protect adjacent high-value stands.

INTRODUCTION

The Douglas-fir beetle[1] (DFB) is the most destructive bark beetle infesting Douglas-fir[2] throughout its natural range in the western United States, British Columbia, and Mexico. During endemic conditions, infestation by low populations of DFB is correlated with root diseases in mature trees, but mortality can be devastating when populations are allowed to breed to large numbers in trees felled by wind or top broken by snow (Furniss and others 1981). The extent to which these enlarged populations kill standing trees depends on management practices and stand conditions.

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[1] _Dendroctonus pseudotsugae_ Hopk.
[2] _Pseudotsugae menziesii_ Mirb. (Franco)

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Stand susceptibility is increased with dense mature-overmature pure Douglas-fir, drought, and defoliation by Douglas-fir tussock moth[3] and western spruce budworm[4]. The correlation with root disease-infected trees is less strong where epidemics are triggered from catastrophic factors. Present management practices for Douglas-fir beetle require immediate salvage of infested windthrow and dying trees prior to emergence of the new pest population. This type of control, although effective, can be thwarted by such factors as accessibility of infested host, weather, markets, salvage timing, availibility of logging operators, probability of populations moving and expanding into susceptible stands, and failure to detect infested trees and windthrow (Pitman 1973). Failure to implement some type of integrated control strategy can result in catastrophic losses such as those that occurred in Oregon and Washington from 1950 through 1959 during which 7.4 billion board feet of merchantable timber were killed. Also, the 1966 epidemic in California killed 800 MMBF of timber, and an outbreak that developed in 1969-70 following felling of trees for the Dworshak Reservoir and from ice and snow breakage killed 111 MMBF of mature Douglas-fir in the North Fork Clearwater River drainage from 1970 through 1975 (Furniss and others 1979).

Since 1970, a concerted effort has continued to develop the antiaggregative pheromone 3-methyl-2-cyclohexen-1-one (MCH) as an operational tool as part of an integrated management strategy to prevent outbreak development and resultant tree mortality (Dyar and Hall 1977; Furniss and others 1974; Furniss and others 1976; Furniss and others 1977; Furniss and others 1981; Furniss and others 1982; McGregor and others 1984).

Since 1972, many small-scale tests coupled with this pilot control project have demonstrated (1) the reliability of the equipment, and (2) MCH reduced Douglas-fir beetle populations by 95 percent in down trees.

Where thinning of susceptible stands and salvage of fresh windthrow is not feasible or possible or where aesthetic or other values preclude thinning or logging, a combination of other management strategies may be needed (Knopf and Pitman 1972; Pitman 1973; Hedden and Pitman 1978; McGregor and others 1984).

One of the primary objectives of the pilot project was to determine if MCH would reduce Douglas-fir beetle-caused mortality in surrounding susceptible stands. This paper reports results of aerial photography and ground examination of infested groups of trees in treated and untreated blocks and in adjacent stands from 1982 through 1984.

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[3] *Orgyia pseudotsugae* McDunn.

[4] *Choristoneura occidentalis* Free.

METHODS

In November 1981, strong winds blew down thousands of trees in north Idaho forests, setting the stage for development of DFB as well as spruce beetle[5], which breeds prolifically in wind-felled Engelmann spruce.[6] This event provided the opportunity to test MCH under more natural conditions than had been possible previously (McGregor and others 1984).

Treated and untreated plots and surrounding stands within 3 miles were photographed with true color film (Kodak aerographic color negative 2445) in 1982, 1983, and 1984. All groups of infested trees were counted within the overlap portion of each stereopair. Approximately 44 photos were taken in each area yearly. Photo stereopairs were examined with a Bausch and Lomb 240 zoom stereomicroscope (10X) by photointerpreters, and a detailed count was made of discolored trees by species. Care was taken to separate lodgepole[7] and ponderosa pines[8] killed by mountain pine beetle, Engelmann spruce killed by spruce beetle, grand fir[9] killed by the fir engraver beetle,[10] and subalpine fir[11] killed by western balsam bark beetle[12] from trees killed by Douglas-fir beetle.

The work plan called for ground crews to visit and inventory all infested groups of trees during 1982, 1983, and 1984. Since neither time nor funds permitted this to be accomplished, a selected sample of infested groups was evaluated. Ground truth data tallied from each group examined were numbers of trees killed/year, d.b.h., height, age, habitat type, aspect, elevation, and slope.

Because photos were late in being interpreted and returned, ground truth was completed one season after photos were taken in 1982 and 1983. However, we do not feel this affected accuracy in determining tree mortality/year during acquisition of ground truth.

RESULTS AND CONCLUSIONS

Results of photointerpretation and ground truth are shown in Table 1.

Areas evaluated showed the following:

1. Scattered faders occurred in the treated area at Cow Creek, one tree was successfully attacked by Douglas-fir beetle in 1981, four in 1982, and three in 1983. Current-year (1984) attacks were not found.

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[5] Dendroctonus rufipennis (Kirby)
[6] Picea engelmanii Parry
[7] Pinus contorta Dougl.
[8] Pinus ponderosa Laws
[9] Abies grandis (Dougl.) Lindl.
[10] Scolytus ventralis LeConte
[11] Abies lasiocarpa (Hook.) Nutt.
[12] Dryocoetes confusus Swaine

Table 1.--Photo and ground evaluations of MCH treated plots and check areas, Nezperce and Payette National Forests, 1982-1984.

	TREATED									CHECKS								
	1982			1983			1984			1982			1983			1984		
Area	Groups of faders	No. trees infested		Groups of faders	No. trees infested		Groups of faders	No. trees infested		Groups of faders	No. trees infested		Groups of faders	No. trees infested		Groups of faders	No. trees infested	
NEZPERCE NATIONAL FOREST																		
Cow Creek		S*	U**		S	U		S	U		S	U		S	U		S	U
	Scattered trees	4	0	Scattered trees	3	0	Scattered trees	0	0	29	54	1	49	232*** photo 83 ground	0	31	94	28
Avg. D.B.H.		37.5			30.6						21.6	14.9		22.4		20.5	20.5	20.3
Red River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAYETTE NATIONAL FOREST																		
Squaw Flats	1 single tree	1	0	0	0	0	0	0	0	0	0	[illegible]	4	4 All strip attacked	0	8	37 photo 34 ground	1
Avg. D.B.H.		Strip attacked												35.0			28.2	18.0

*S = Successfully attacked tree
**U = Unsuccessfully attacked tree
*** = The two numbers denote differences in counts from the photos and on the ground

2. Two groups of faders evaluated were close to the Cow Creek treated plot. The first group, one-eighth mile away, showed two trees were killed in 1982, three in 1983, and one was killed and four were unsuccessfully attacked in 1984. In the second group, one-half mile away, four trees were strip attacked in 1983-84, two were killed and four were unsuccessfully attacked in 1984.

3. No infested groups of trees occurred in treated areas at Dixie Summit, Nezperce NF, or Squaw Flats, Payette NF, during 1982, 1983, or 1984. One Douglas-fir was strip attacked in the treated plot at Squaw Flats in 1982.

In check areas the following was found:

1. Twenty-nine groups of faders containing 54 successfully attacked trees and one unsuccessfully attacked tree occurred at Cow Creek in 1982, 49 groups of faders with 232 infested trees in 1983, and 31 groups containing 94 successfully attacked trees in 1984.

2. No infested trees were observed during 1982, 1983, or 1984 at Dixie Summit, Nezperce NF.

3. At Squaw Flats, Payette NF, no infested trees were observed in 1982, four groups of trees with all trees being strip attacked in 1983, and eight groups with 33 successfully attacked trees and one unsuccessful attack in 1984.

Group size in the check areas ranged from 1 to 14 (average 3.7) trees/group in 1982, 1 to 17 (average 5.4) trees/group in 1983, and 1 to 17 (average 4.2) trees/group in 1984 at Cow Creek. At Squaw Flats group size ranged from 1 to 10 (average 4) trees/group in 1982, 1 to 6 (average 3.5) trees/group in 1983, and 3 to 10 (average 7.7) trees/group in 1984.

Stand data are presented in Table 2.

Table 2.--Stand data from Cow Creek, Dixie Summmit, and Squaw Flats, MCH pilot project, Nezperce and Payette National Forests, 1982.

	Nezperce National Forest		Payette National Forest
	Cow Creek	Dixie Summit	Squaw Flats
Average age - Douglas-fir	117	150	150
Percent Douglas-fir in stand	70-80	25	50-60
Basal area ft^2/acre	140	200	60-120
Habitat type	ABGR/CLUN	ABLA/LIBO ABLA/COOC	ABLA/VASC ABLA/CAGE ABLA/CARU
Elevation	6,000	5,800	6,302

From observations of past outbreaks (Furniss and others 1979; Furniss unpublished data 1981), we can say the following concerning susceptibility of stands associated with windthrow during this pilot project.

Age--Douglas-fir in treated and check areas range from 60 to 200 years old. However, attacked trees range from 117 to 150 years old. The average age of hundreds of DFB-killed trees that we have examined exceed 120 years (Furniss and others 1981). Age of attacked trees varies with locality and population pressure. During an outbreak in the Clearwater River drainage, Douglas-fir in very dense stands (250 sq. ft. BA/ac.) contained trees 80 years old or less that were attacked. However, such young trees seldom die from attack, and if young trees are attacked and killed, it is usually under intense beetle pressure (Furniss and others 1981).

Percent Douglas-fir in Stand--Major factors involved in susceptibility of dense Douglas-fir stands are moisture stress and shaded stem environment. Douglas-fir beetles avoid the hot, sun-exposed portion of felled stems and attack the less dense lower boles of standing trees (Furniss 1962). We feel one reason for fewer trees being killed in the Squaw Flat area was partially due to the low stand density. We know from past observations that after dense stands are cut, greater illumination and higher temperatures discourage beetles from arresting on trees (Furniss and others 1981). This is one factor that seems to account for lower susceptibility and fewer trees being killed in those stands. Stands at Cow Creek Saddle were much more dense resulting in higher susceptibility as borne out by the number of epicenters that developed.

Habitat Type and Species Diversity--Mortality groups consistently contained more Douglas-fir than other tree species. In northern and central Idaho, Douglas-fir is recognized as a climax or major seral species in 40 habitat types. No systematic attempt has been made to rank habitat types for DFB hazard, but some impressions have been obtained through evaluations (Furniss unpublished data). In many stands evaluated the past 15 years, Douglas-fir was ranked for susceptibility for outbreak development by habitat type. Infestation frequency was ranked from high to low in stands containing these habitat types: THPL/PAMY (32 percent), PSME/PHMY (17 percent), PSME/CAGE (16 percent), PSME/SPBE (13 percent), PSME/ACGL (13 percent), PSME/CARU (5 percent), and ABGR/PAMY (4 percent).

Frequently, Douglas-fir habitat types of the *Spirea betulifoliae*, *Physocarpus malvaceus*, and *Symphonicarpus albus* contain stands with a good mixture of ponderosa pine. This mixture restricts DFB mortality to dense, older age groups of Douglas-fir of limited area, particularly during drought years (Furniss and others 1981).

This was obvious in the Squaw Flats plots. Douglas-fir occurred in very clumpy patches, was old growth, and comprised 50 to 60 percent of the stands. Stands with more dense cover contained a large percentage of subalpine fir-lodgepole pine. The PSME/CAGE habitat type is more common and often restricts Douglas-fir regeneration. This habitat type tends not to support closed, more susceptible stands (Furniss and others 1981). Douglas-fir mortality from DFB would be of short duration and low intensity, as borne out by the amount of mortality noted on photos and during ground checking.

At Dixie Summit, Douglas-fir comprised only 25 percent of the stand. Subalpine fir, Engelmann spruce, and lodgepole pine comprised 75 percent of the stand. Mortality to residual Douglas-fir was nil on these more mesic habitat types from 1982 through 1984 following spraying.

Tree mortality was much higher on the more xeric sites with steeper slopes (30 percent, and purer Douglas-fir stands at Cow Creek plots. The number of infested spots and tree mortality were much higher in check areas and in stands adjacent to check areas from 1982 to 1984 (Table 1). Based on photointerpretation, ground evaluation, and data from Table 1, we conclude the following:

1. Treated plots received very few successful attacks, while untreated checks had a high percentage of successfully attacked trees.

2. Trees killed nearest to treated plots were one-eighth to one-half mile from the plot boundary.

3. In all treated areas, successful attacks in surrounding stands declined sharply by the second season after DFB emergence from windthrow. This pattern is identical to what has been experienced in natural infestations.

4. In all check areas and surrounding areas, the number of pitchouts increased with successive years of infestation, and average diameter of trees infested declined from the first to the second season following emergence of DFB from windthrow. This pattern is also identical to that experienced following a buildup in windthrow in other outbreaks.

DISCUSSION

It appears that the MCH treatment was very effective in repelling DFB from treated plots. The fact that only one treated plot had any trees attacked in or very close to the plot suggests that the MCH odor probably diffused beyond the boundaries of the treated plots resulting in protection of adjacent stands. Although we do not have data that shows how far beetles were dispersed from treated plots, we are of the opinion that because so few infested trees occurred in treated and adjacent stands, beetles must have been dispersed quite a distance. Beetles disseminated by MCH are probably dispersed more widely and would search windthrow, slash, or stressed trees. Wide dispersal would prevent concentration of a sufficient number of beetles to cause an epicenter. Dispersal of beetles over a wide area, and an increase in flight time results in in-flight mortality and increased predation (R. F. Schmitz, personal communication 1985) (Moeck and Safranyik 1984; Atkins and McMullin 1960; Atkins 1961).

Dispersing beetles over a wide area and diluting the population probably resulted in an insufficient number of beetles to successfully attack trees, thus accounting for the increase in pitchouts from 1983 to 1984. These unsuccessfully attacked trees serve as population sinks (Table 1).

We also feel that by dispersing beetles, many succeeded in flying into windthrow in adjacent check areas, which might account for the increased tree mortality in check areas (R. F.Schmitz, personal communication 1985).

Since we were successful in protecting treated plots and adjacent stands, and since the treated plots were protected for 2 years following treatment, we consider MCH to be an effective treatment for protecting high-value stands.

Based on the data provided, we recommend that MCH be registered with the EPA at 2 percent controlled release formulation for application to inaccessible windfelled trees and high-value stands at the rate of 4.48 kg/ha (89.7 g AI). Once registered, an operational tool will be available for preventing a population buildup in windthrown trees and adjacent stands.

REFERENCES

Atkins, M. D. A study of the flight of the Douglas-fir beetle, Dencroctonus pseudotsugae Hopk. (Coleoptera: Scolytidae) III Flight capacity. Can. Entomol. 63(6): 467-474. 1961.

Atkins, M. D. and L. H. McMullen. On certain factors influencing Douglas-fir beetle populations. Fifth World Forestry Congress August 29 to September 10, Seattle, WA. 4 p. 1960.

Dyer, E. D. A., and P. H. Hall. Effect of anti-aggregation pheromones 3,2-MCH and trans-verbenol on Dendroctonus rufipennis attacks on spruce stumps. Journal Entomol. Soc. B.C. 74: 32-34. 1977.

Furniss, M. M. Infestation patterns of Douglas-fir beetle in standing and windthrown trees in southern Idaho. Journal Econ. Entomol. 55: 486-491. 1962.

Furniss, M. M., G. E. Daterman, L. N. Kline, M. D. McGregor, G. E. Trostle, L. F. Pettinger, and J. A. Rudinsky. Effectiveness of the Douglas-fir beetle anti-aggregative pheromone methylcyclohexenone at three concentrations and spacings around felled host trees. Can. Entomol. 106: 381-392. 1974.

Furniss, M. M., B. H. Baker, and B. B. Hostetler. Aggregation of spruce beetles (Coleoptera) to sendenol and repression of attraction by methylcyclohexenone in Alaska. Can. Entomol. 108: 1297-1302. 1976.

Furniss, M. M., J. W. Young, M. D. McGregor, R. L. Livingston, and D. R. Hamel. Effectivness of controlled-release formulations of MCH for preventing Douglas-fir beetle (Coleoptera: Scolytidae) infestations in felled trees. Can. Entomol. 109: 1063-1069. 1977.

Furniss, M. M., M. D. McGregor, M. W. Kviles, and A. D. Partridge. Chronology and characteristics of a Douglas-fir beetle outbreak in northern Idaho. USDA For. Serv., Intermt. Forest and Range Expt. Sta. Gen. Tech. Rept. INT-59, 19 p. 1979.

Furniss, M. M., R. L. Livingston, and M. D. McGregor. Development of a stand susceptibility classification for Douglas-fir beetle. P. 115-128. In: Hedden, R. L., S. J. Barras, and J. E. Coster Tech. coords., Hazard Rating Systems in Forest Pest Management. Proc. Symp. July 31-August 1, 1980, Athens, GA. USDA For. Serv. Gen. Tech. Rept. 1981.

Furniss, M. M., E. P. Markin and V. J. Hager. Aerial application of Douglas-fir antiaggregative pheromone; equipment and evaluation. USDA For. Serv. Gen. Tech. Rept. INT-137, 9 p. 1982.

Hedden, R. L. and G. B. Pitman. Attack density regulation: a new approach to the use of pheromones in Douglas-fir beetle population management. Journal Econ. Entomol. 71(4) 633-637. 1978.

Knopf, J. A. E. and G. B. Pitman. Aggregation pheromone for manipulation of the Douglas-fir beetle. Journal Econ. Entomol. 65)3) 723-726. 1972.

McGregor, M. M., M. M. Furniss, R. D. Oakes, K. E. Gibson, H. E. Meyer. MCH pheromone for preventing Douglas-fir beetle infestation in windthrown trees. Journal of Forestry 82(10) 613-616. 1984.

Moeck, H. A., and L. Safranyik. Assessment of predator and parasitoid control of bark beetles. Environment Canada, Canadian Forestry Service, Pacific Forest Research Centre, Information Report BC-X-248. 24 p. 1984.

Pitman, G. B. Further observations on Douglure in a Dendroctonus pseudotsugae management system. Environmental Ent. 2(1) 109-117. 1973.